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FAULT DISPLACEMENT AND FOLD CONTRACTION ESTIMATED BY UNFOLDING OF QUATERNARY STRATA, ONSHORE AND OFFSHORE VENTURA BASIN, CALIFORNIA

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ABSTRACT

We created digital subsurface maps on Quaternary horizons through onshore and offshore Ventura basin and the faults and folds that make up the northern margin of that basin. The software UNFOLD was used to restore the digital maps to an initial horizontal state. The unfolded surfaces in each fault and fold block were fit together and compared to the present deformed state to result in a model for horizontal displacement. The original project focused on the Oak Ridge fault, while this renewal project focuses on the Pitas Point fault, North Channel fault, and south branch of the Red Mountain fault. Reflections from these faults are imaged on the seismic reflection profiles used for mapping, and faults were also mapped from the sea floor geology and detected by repeated sections and abrupt dip changes in wells. The renewal project resulted in 34 digital structure-contour maps of the top Lower Pico Formation (~1.8 Ma) on fault-bounded blocks. The onshore maps were constructed in depth from numerous cross sections, while the offshore maps were constructed in travel time from industry seismic reflection data tied to 45 wells and converted to depth using velocity models derived from wells.

The N-dipping Pitas Point fault and the North Channel fault are distinct from each other in cross section but are stacked to map along the same E-W trend in northern Santa Barbara Channel. Both faults intersect in the upper 1 km, with the Pitas Point fault dipping more steeply to diverge down-dip. The south branch of the offshore Red Mountain fault is a separate parallel structure 6 km to the north. The Red Mountain fault splays into two main branches near the Carpinteria coast. The northern branch decreases in displacement to the west and continues west of the UCSB campus where it may die into folding. The south branch also decreases in displacement to the west and dies out in a syncline south of Santa Barbara. The North Channel and Red Mountain faults probably intersect with depth, detaching the intervening upper

crustal block. Displacement is transferred from one fault to another via NE-SW cross faults and probably by vertical-axis local block rotations. Major cross faults are mapped or inferred near Santa Paula, along the Ventura River, southwest of Rincon Point, and from Fernald Point to south of Santa Barbara. Abrupt changes in shortening and fault-fold style along the strike of the Pitas Point and North Channel faults occur across these NE-SW faults. Unfolding and restoration of the 34 digital maps on the 1.8 Ma horizon indicates shortening varying from 1 km south of the UCSB campus to 3 km between Santa Barbara and Carpinteria. This averages to less than 1-2 mm/yr. rate is much less than the GPS rate of 5-6 mm/yr. across this area. The difference is probably due to shortening in the hanging-wall north of the Red Mountain fault, acceleration of the shortening rate since 1.8 Ma, and because sediment compaction within offshore Ventura basin causes an apparent shortening in the GPS data. Most of the folding south of the UCSB campus post-dates 1 million years ago, and young folding is suggested but not yet proved south of Santa Barbara and Carpinteria. In addition, folding rates appear to be higher in the last half million years than before, and the fold and thrust belt in northern Santa Barbara Channel may now accommodate shortening at rates approaching the GPS-derived motions.